DARPA:
Future Research Directions

Scientists Helping America Conference

Dr. Tony Tether
DARPA Director

March 12, 2002

DARPA Organization

Director, Tony Tether
Deputy Director, Jane Alexander

Information Exploitation
Richard Wishner
Stephen Welby
Robert Tenney

Sensors

Exploitation

Systems

Command &

Tactical Technology
Allen Adler
Art Morrish

Air/Space/Land Platforms
Unmanned Systems
Space Operations
Laser Systems
Future Combat Systems
Planning / Logistics

Special Projects
Amy Alving
Joe Guerci

Chem/Bio Def Systems
Counter Underground Facilities
Space Sensors/Structures
Navigation/Sensors / Signal Processing

Advanced Technology
Tom Meyer
William Jeffrey

Assured C3ISR

Maritime

Early Entry/Special Forces

Information Awareness
John Poindexter
Robert Popp

Asymmetric Threat

Prediction

Behavior Modeling

Defense Sciences
Michael Goldblatt
Steven Wax

Bio Warfare Defense Technologies
Biology
Materials & Devices
Mathematics

Information Technology
Kathy MacDonald
Doug Schmidt

Architectures & Designs
Computer Processing & Storage
Networks
Human Computing Interfaces

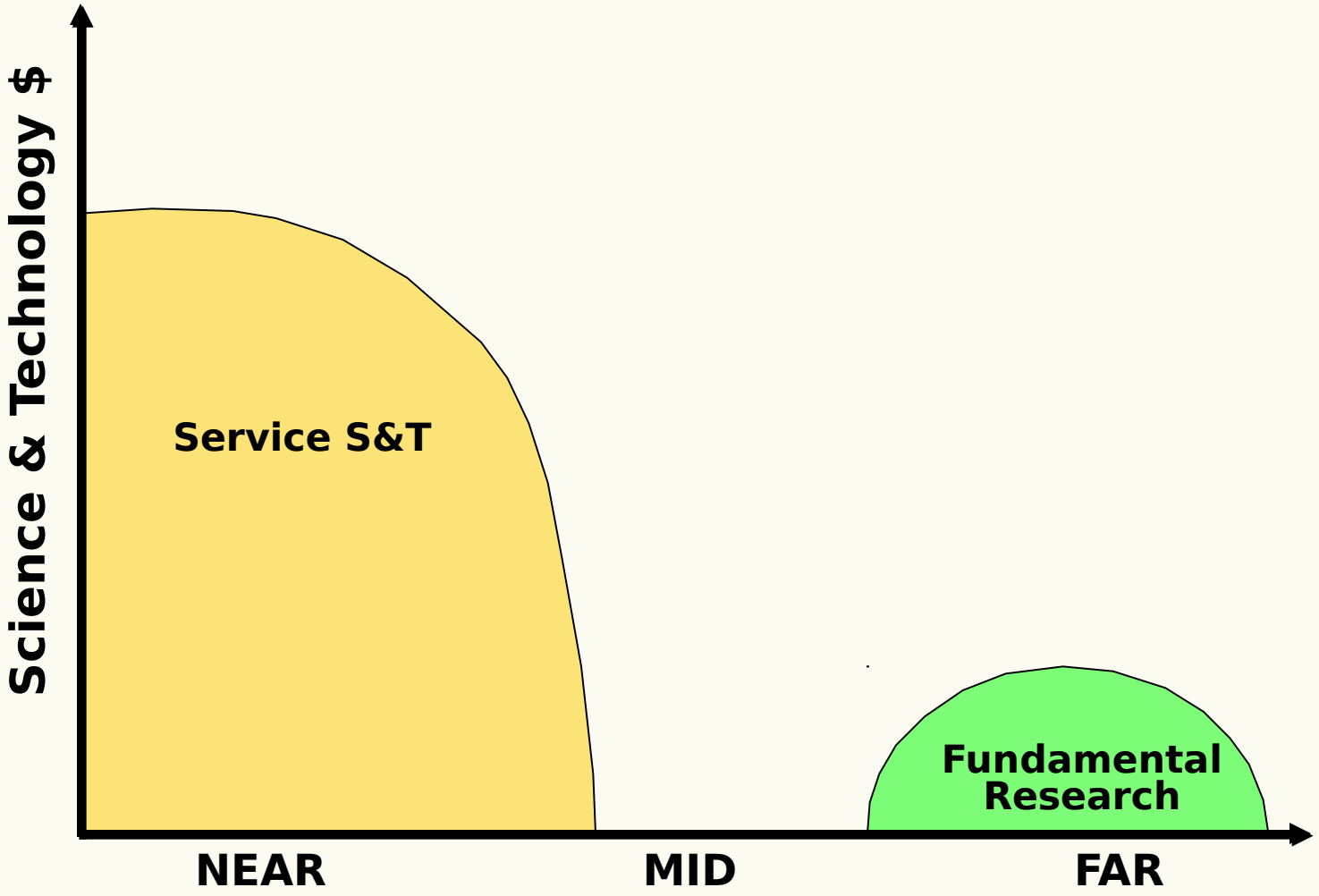
MicrosystemsTechnology
Robert Leheny
Dave Honey

Electronics
Optoelectronics
MEMS
Combined Microsystems

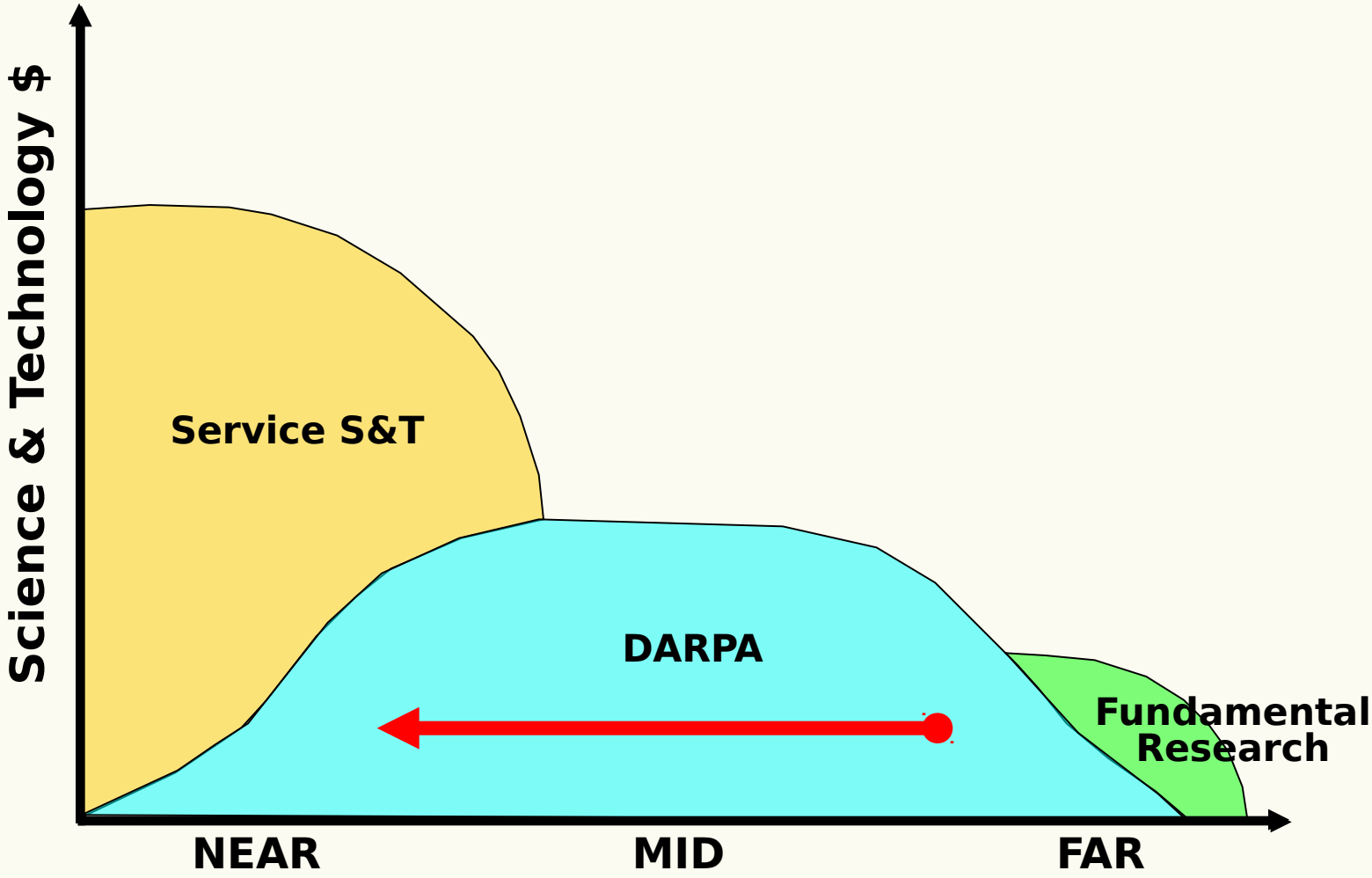
Current Focus Areas

- **National-Level Problems**
  - **Protection from Biological Attack**
  - **Protection from Information Attack**
  - **Counter-Terrorism**
  - **Assured use of Space**
- **Operational Dominance**
  - **Affordable, Precision Moving Target Kill**
    - Offensive and Defensive
  - **Dynamic Command & Control**
    - Mobile Networks
    - Near-Real-Time Planning, Replanning
  - **Future Warfare Concepts**
    - Hard and Deeply Buried Target Classification
    - Combined Manned, Unmanned Operations
- **High-Risk, High-Payoff Technology Exploitation**
  - **Information, Microsystems, Math, Materials**
  - **Intersection of Biology, Information and Microsystems**

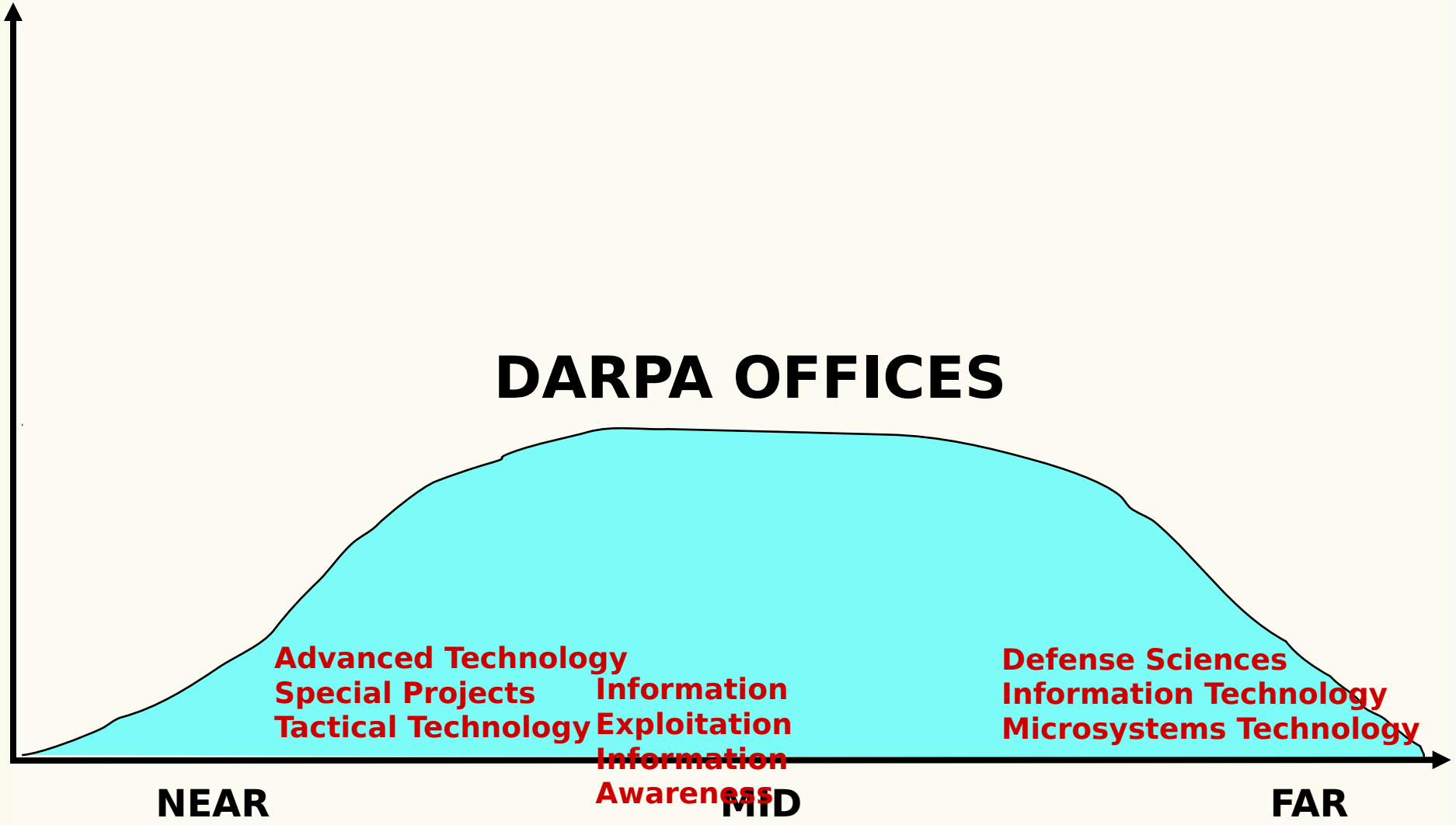
DARPA Role in Science and Technology



DARPA Role in Science and Technology



Internal Technology Flow



DARPA Accomplishments

Saturn

196

0

Vela

Ground Surveillance Radar

197

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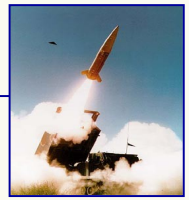

ATACMS

M-16 Rifle

JSTARS

Stealth Fighter

198

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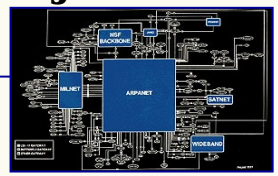


Arpanet

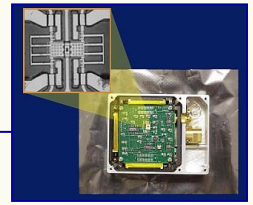
Sea Shadow

GPS

UCAV

Global Hawk

TMR



MEMS

200

0

JSF

MALD

Uncooled IR

BAT

199

0

Taurus Launch Vehicle

Predator

Future Capabilities

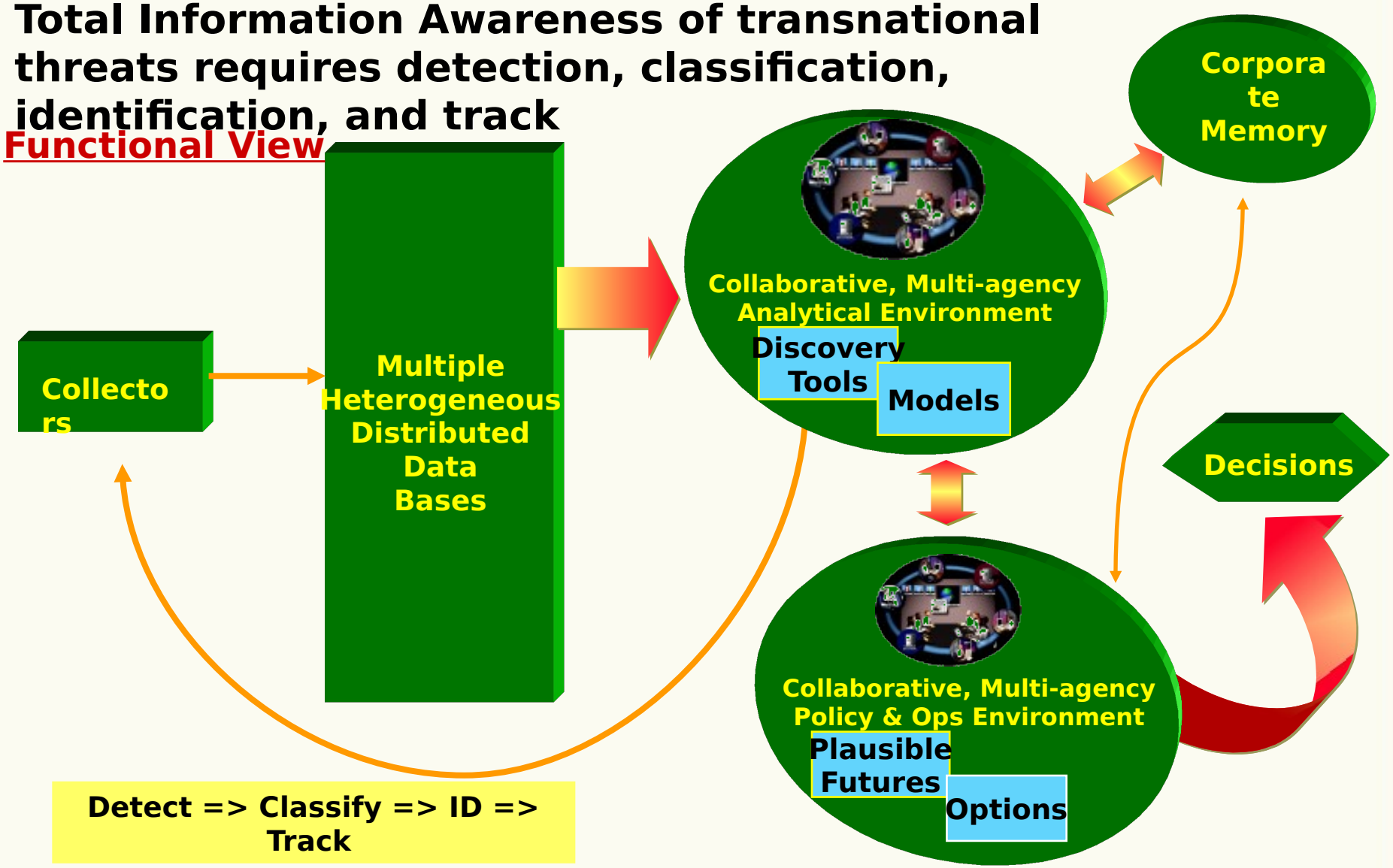
Investments Today for Future Capabilities

- **Defeat terrorist networks**
- **Precision detection, tracking, and destruction of elusive targets**
- **Characterization of underground structures**
- **Combined manned & unmanned attack operations**
- **Assured use of space**
- **Cognitive computer systems**

Bio-Revolution

Defeat Terrorist Networks

Total Information Awareness of transnational threats requires detection, classification, identification, and track



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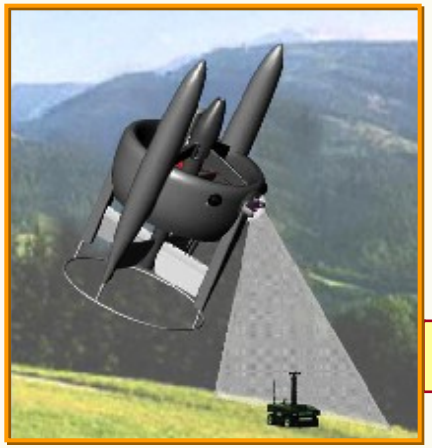
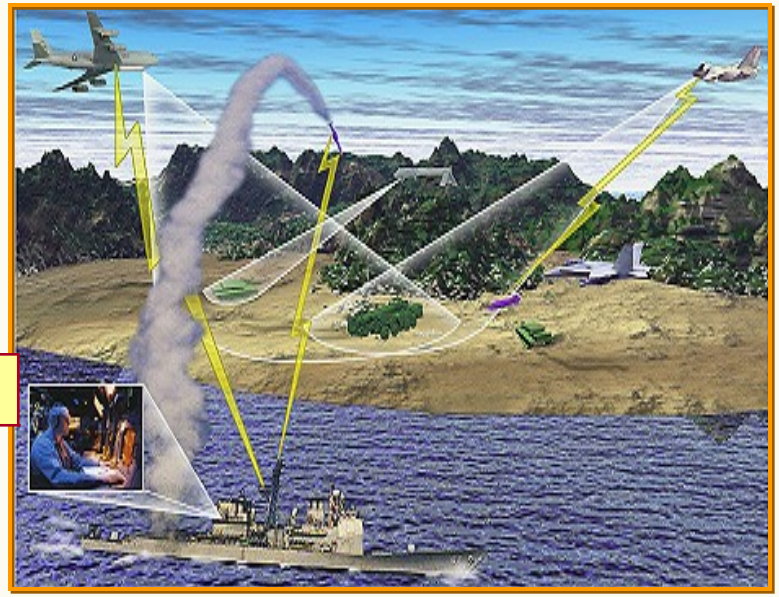
Bio-Revolution

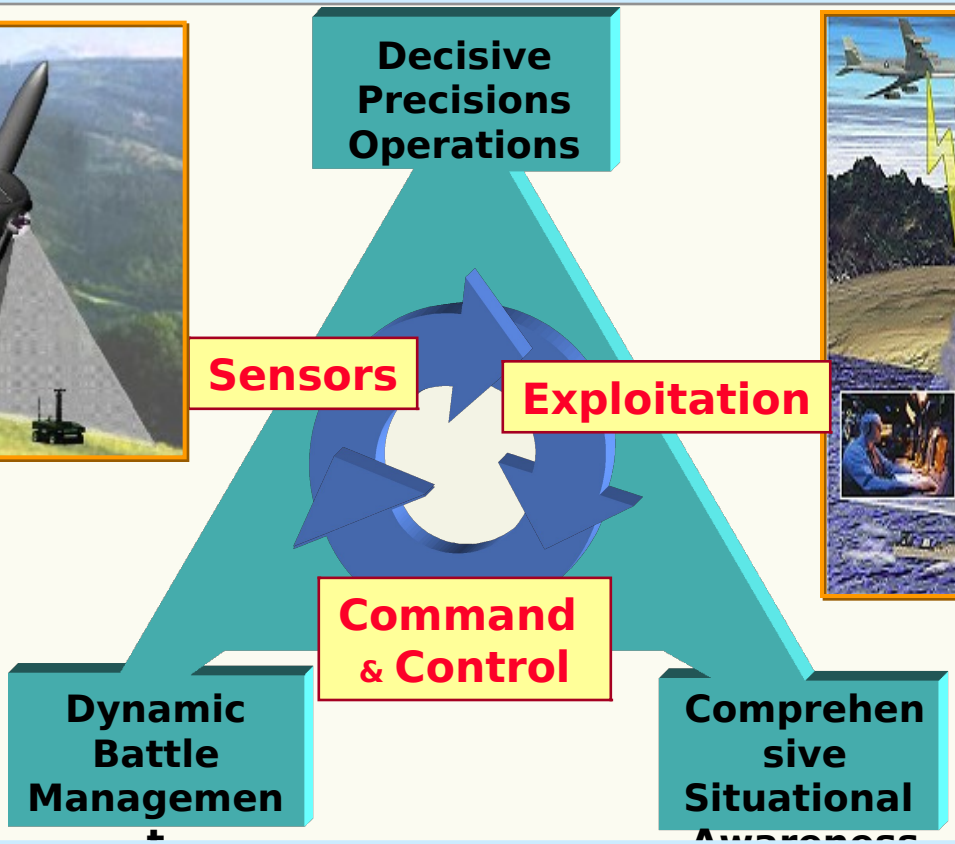
Precision Detection & Tracking

Address systematic challenges associated with surface target interdiction

Detect ➡ Classify ➡ ID ➡ Track ➡ Disseminate
Engage Assess







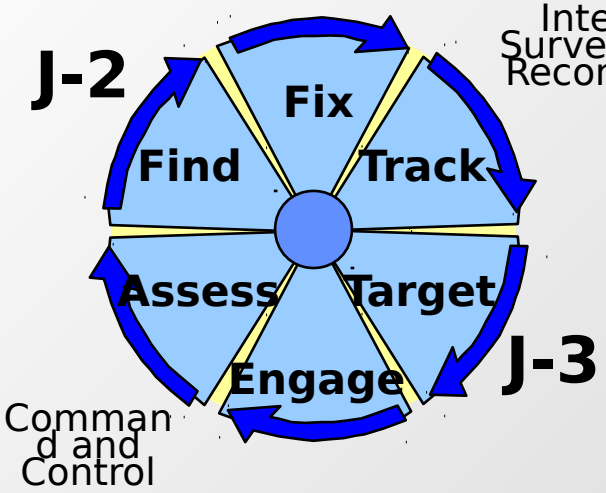
Combat identification confidence and low likelihood of inadvertent collateral damage

Technology Enabled C4KISR: *Paradigm Shift*

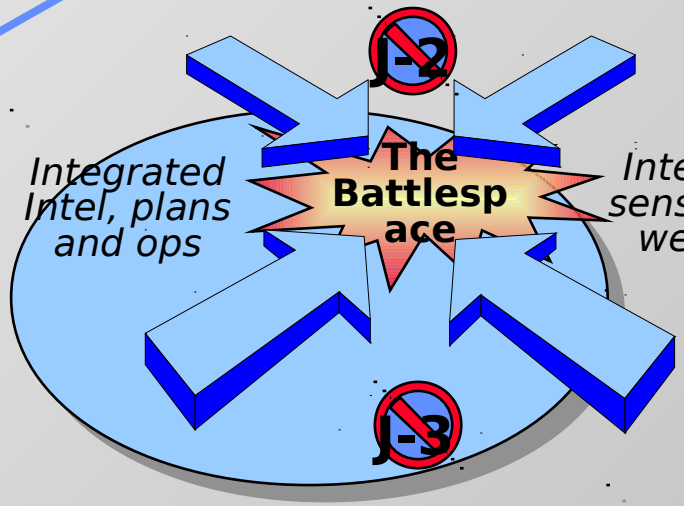
DARPA

Current Paradigm

Sequential
Disjoint
Static
Rigid



New Paradigm



Uninterrupted
Continuous
Dynamic
Adaptive

Continuous, seamless interaction between situation developers and plan developers to create a virtual sensor to shooter link

➔ **Persistent flow of actionable information from sensors to planners and shooters**

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Bio-Revolution

Counter Underground Facilities

Function?

Operational Cycle?

Physical Features/ Vulnerability?

Battle Damage?

Technologies

- **Passive Seismic, Acoustic, Electromagnetic (PASEM)**
- **Effluent Exploitation for "Vent Hunting"**

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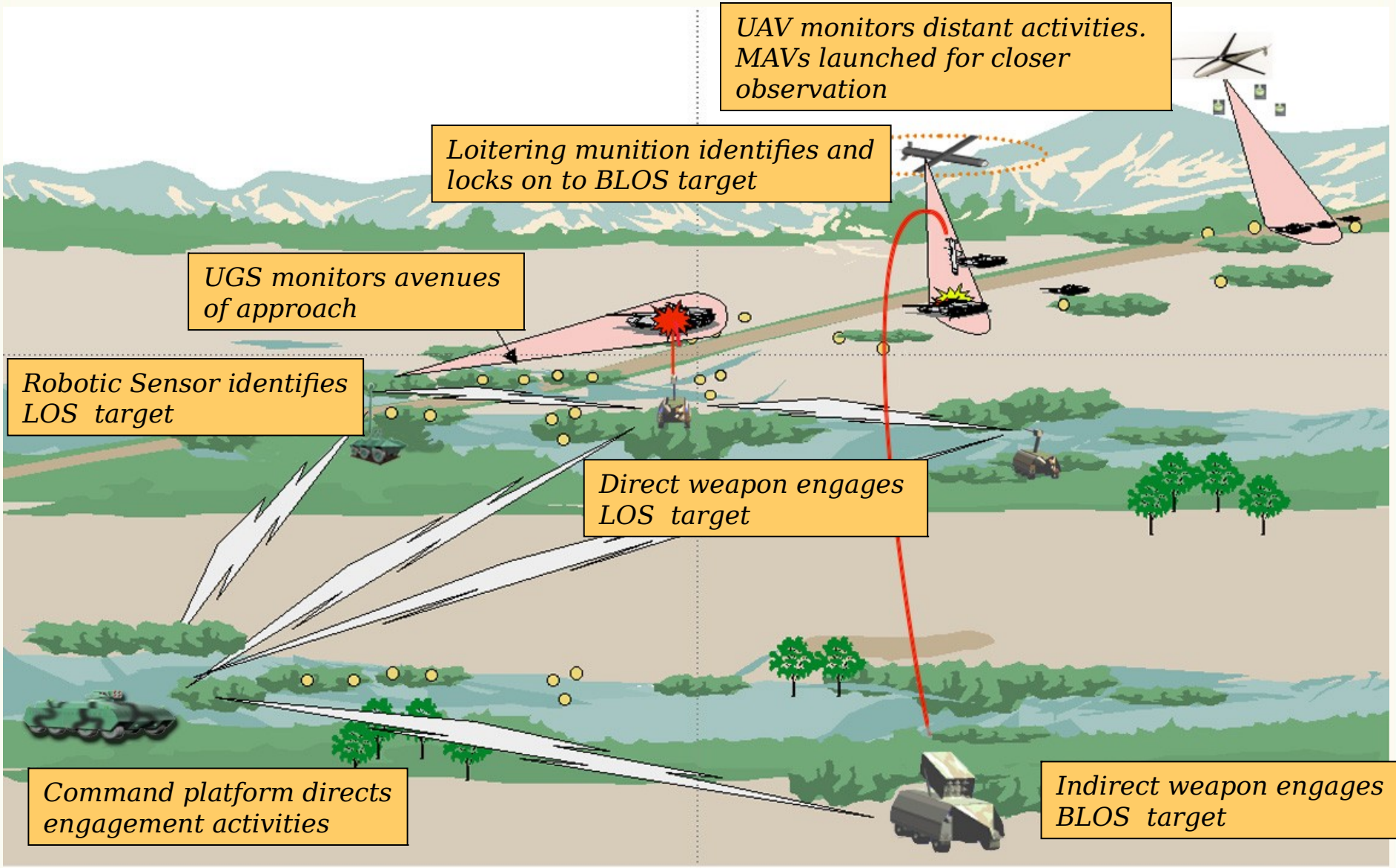
- Bio-Revolution

Combined Manned & Unmanned Systems


UAV monitors distant activities. MAVs launched for closer observation
Loitering munition identifies and locks on to BLOS target
UGS monitors avenues of approach
Robotic Sensor identifies LOS target
Direct weapon engages LOS target
Command platform directs engagement activities
Indirect weapon engages BLOS target

Future Unmanned Air Systems

DARPA

Unmanned Combat Air Vehicle

Unmanned Combat Armed

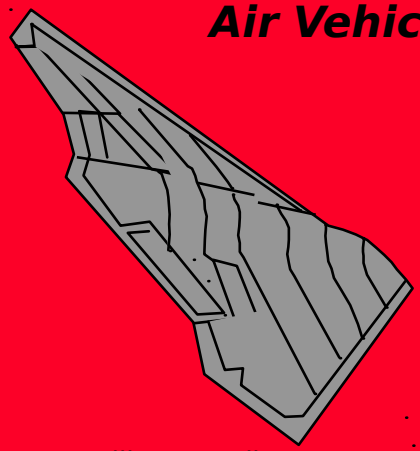
Stealthy Armed
Capabilities

Canard Rotor Wing

Micro Air Vehicle

Reconnaissance and Surveillance
in Support of Unit of Action

Naval Unmanned Combat Air Vehicle



SEAD/Surveillance/Strike

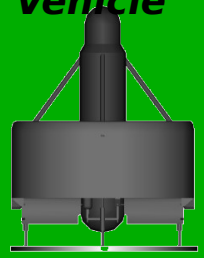
U.S. AIR FORCE

DARPA

A-160 Hummingbird

RSTA and
Utility
Capability

Organic Air Vehicle



Target Acquisition in Support of
FCS

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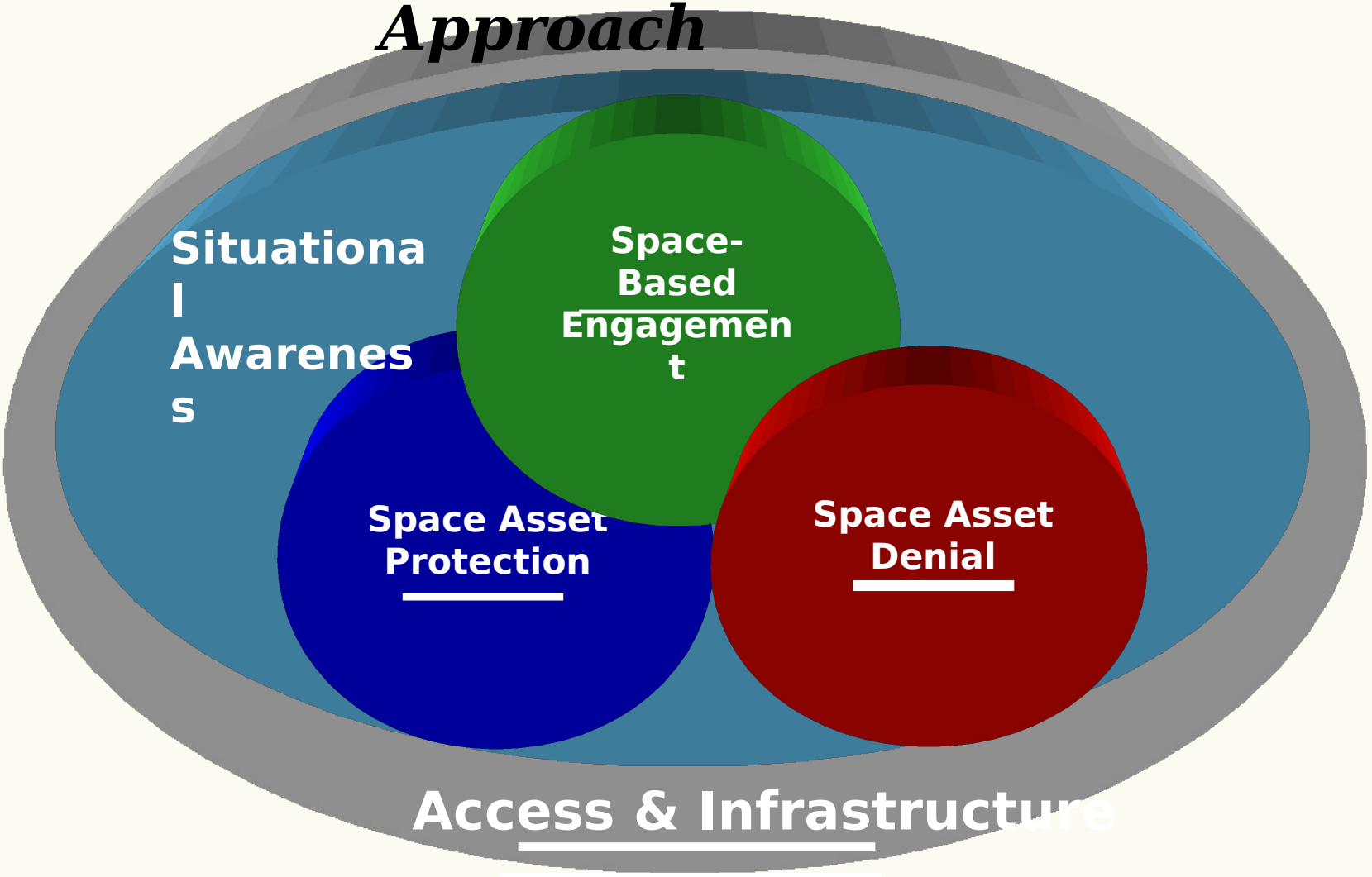
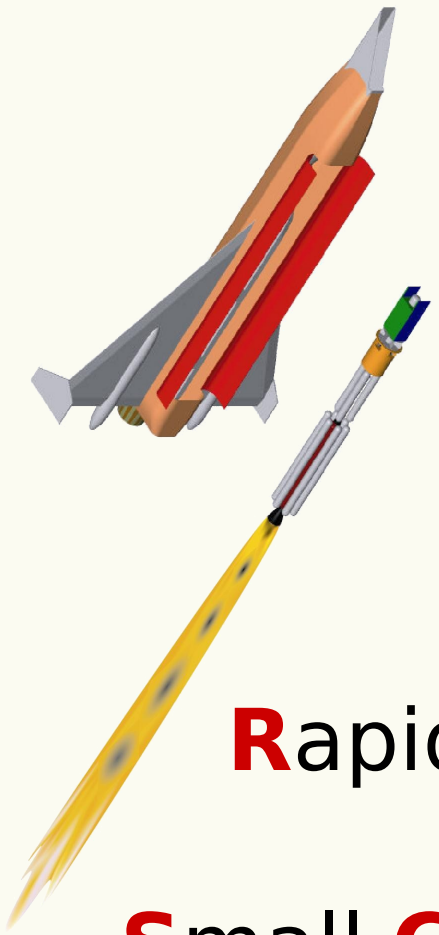
- Bio-Revolution

Space Programs

Comprehensive Approach



RASCAL
PROGRAM DESCRIPTION



Objective: Develop a **Responsive, Routine, access to space for Small Payloads**

Approach: Blend of Reusable & expendable vehicles

- **Reusable aircraft first-stage capable of Exo-Atmospheric flight**
- **Low-cost expendable upper stages**

Goals: **50 kg (110 lbs) to LEO, anytime, any inclination**

high flight rate, on-time performance, Low Cost

Payoffs: **Assured and timely access to space for U.S. defense**

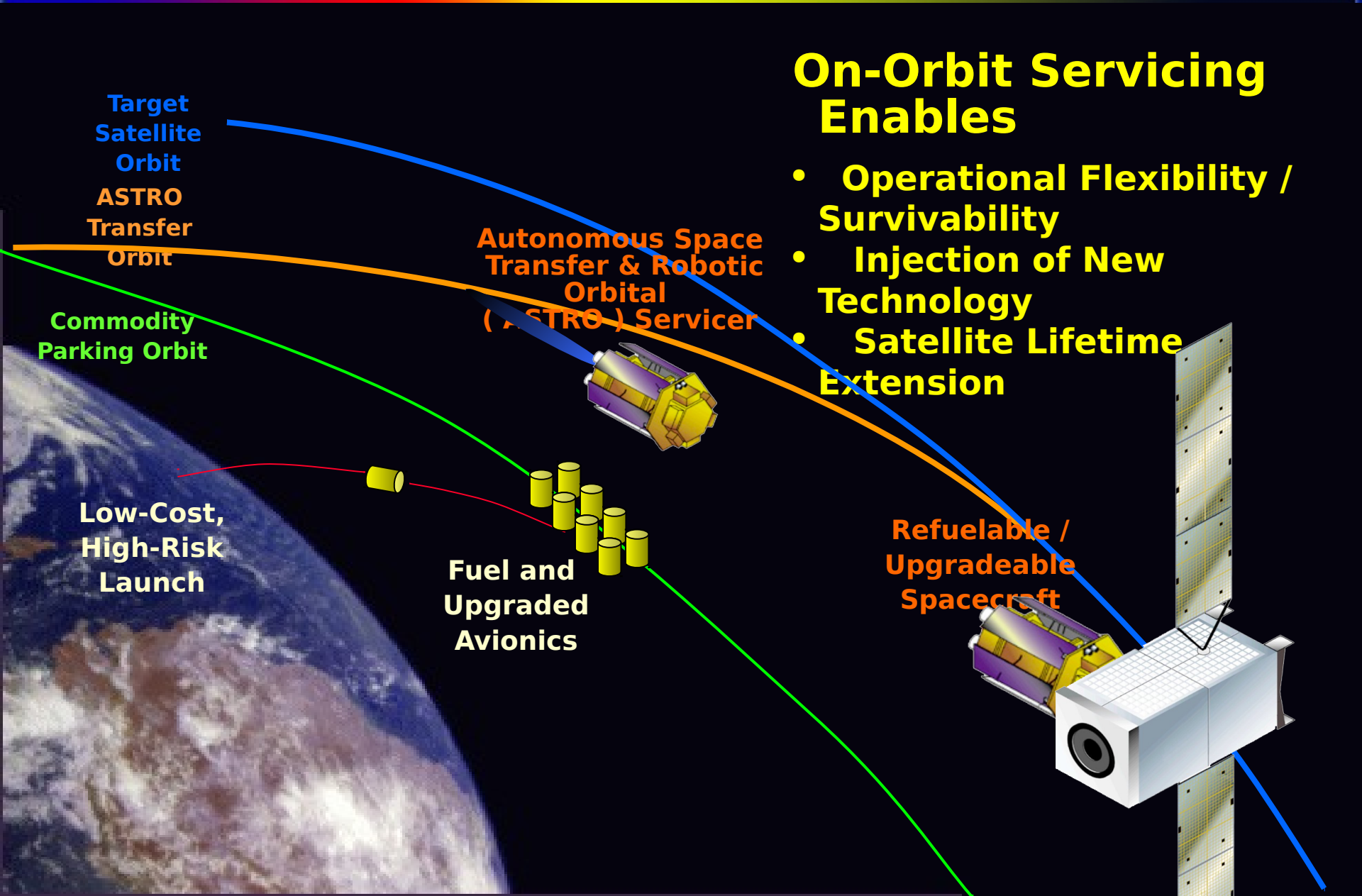
Acts as an enabler for new missions:
- –New military space missions
- –BMDO targets
- –Space Test Program (STP) payloads

Rapid **A**ccess

Small **C**argo

Affordable **L**aunch

Orbital Express System Concept



On-Orbit Servicing Enables

- Operational Flexibility / Survivability
- Injection of New Technology
- Satellite Lifetime Extension

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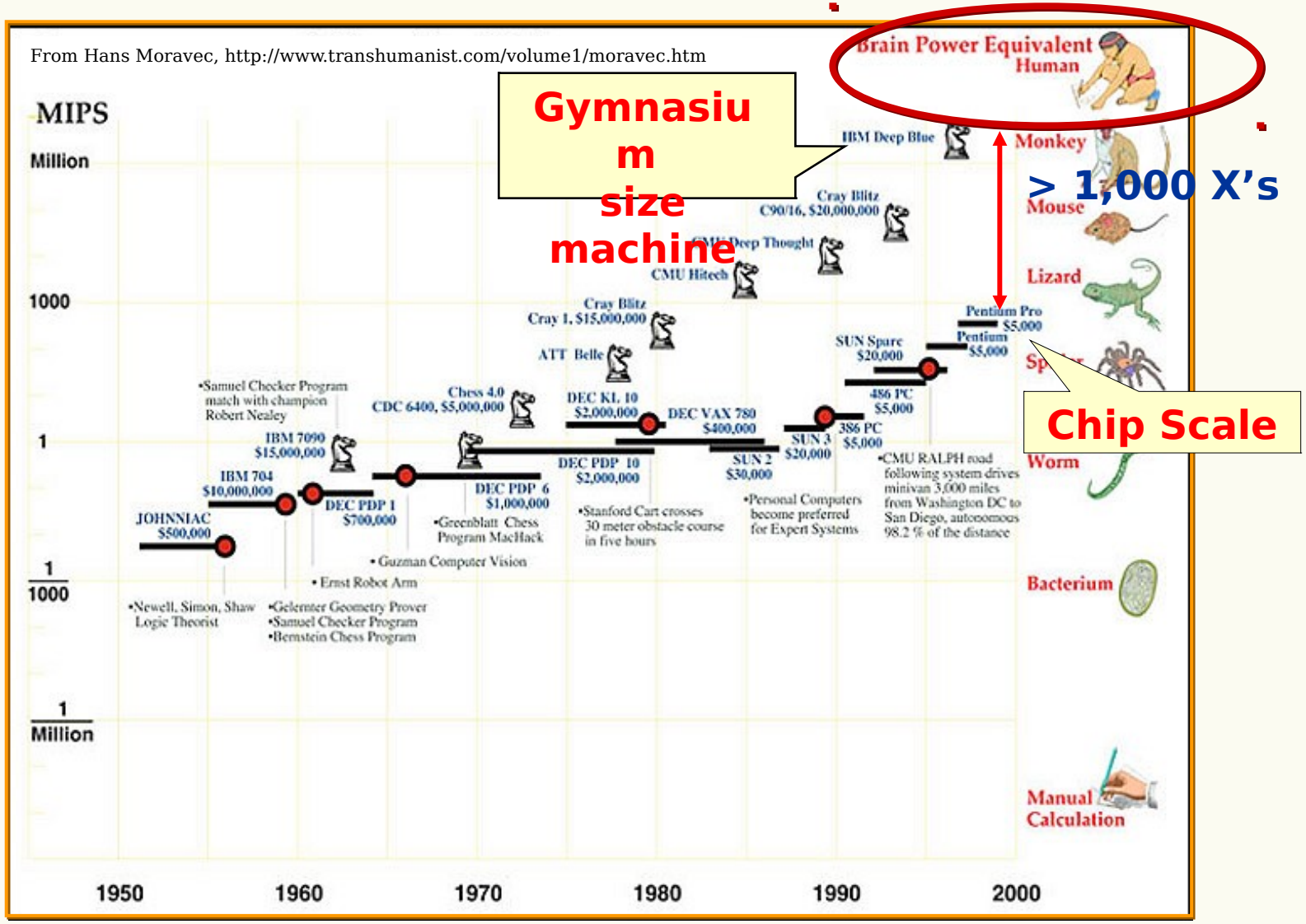
  Bio-Revolution

Cognitive Computer Systems

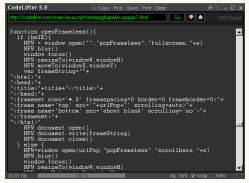
- **Computer Systems are an important part of the glue that holds the DoD infrastructure together.**
  - **Current systems are almost impossible to configure or maintain by non-experts**
    - High labor cost
    - Systems cannot anticipate or explain failures nor react to changes in environment
    - People must adapt to user interfaces, rather than the other way around
- **More general, multi-component systems have coordination and inefficiency problems, and are fragile**

Develop Cognitive Systems That Know What They Are Doing



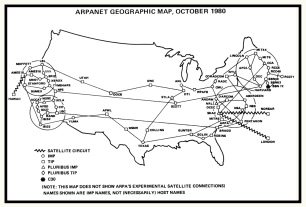
Cognitive Systems Roadmap

Self-aware software



- Extend functionality by means of interactive dialogue
- Actively assist programmer in debugging

Self-aware networks



- Explain causes of network delays
- Self-reconfigure by reasoning about traffic, anomalies
- Information access rules tied to location

Self-aware agents

- Personalize via learning
- Reconfigure by natural language request (“what do you want me to become?”)

Self-aware multi-agent systems

- Automatic cross-component coordination
- Overall cost minimization

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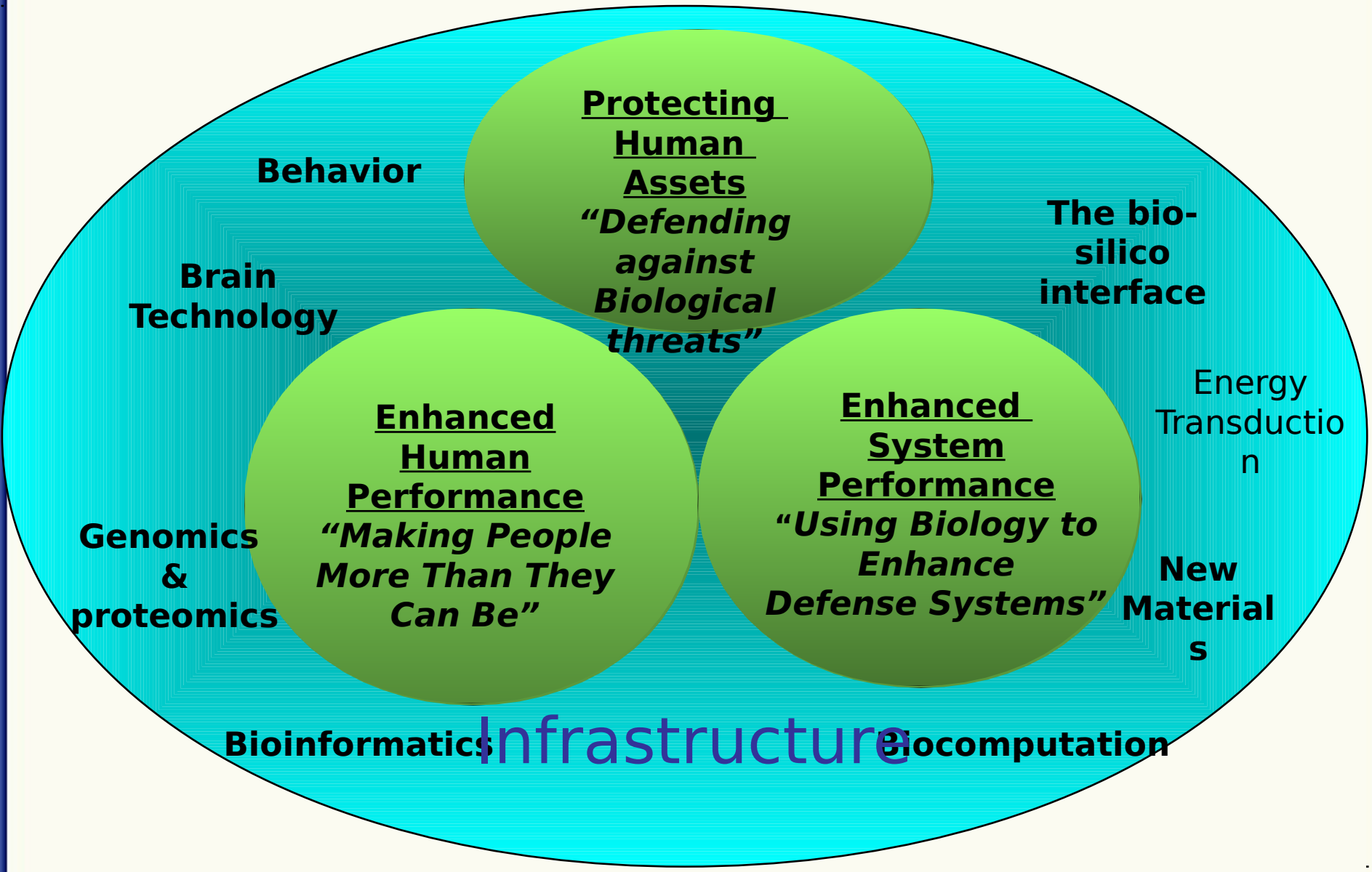
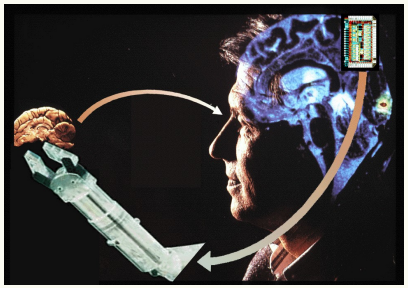
Bio-Revolution

Harvesting Biology for Revolutionary Technologies at DARPA

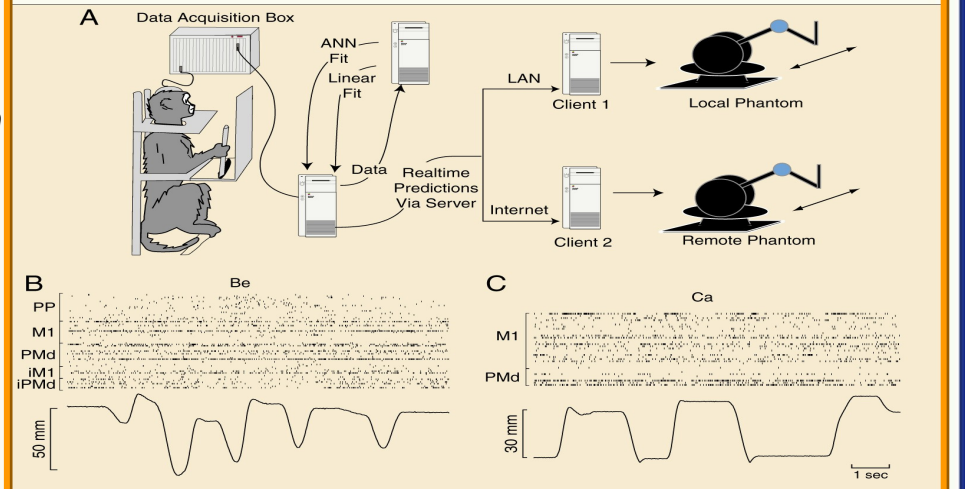


Enhanced Human Performance
Brain Machine Interface

To use brain activity to do work; to command, control, actuate and communicate with the world directly through brain integration with peripheral Devices and Systems

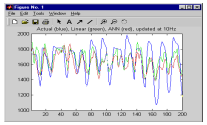


Direct Brain Stimulation of Forc

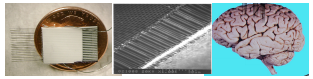


Why Do We Think We Can Do Brain C³ ?

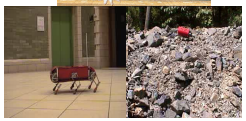
•Neural code commands extracted and used to move a robotic arm

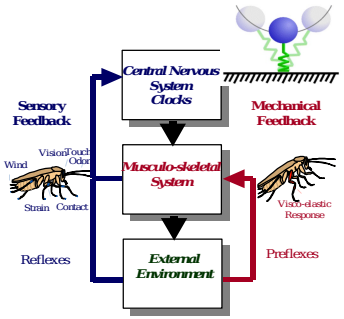


•New high density neural implants



•Better understanding of neuronal and force dynamics interplay





Impact:

- **Direct brain signals could control simple to more complex DoD devices & machines**
- **Direct brain control could be enabled in real-time from remote locations**
- **Understanding how the brain manages and signals deception**

Opportunity

- **DoD Science & Technology Funding Increasing**
  - **Administration Goal is 3% of Top Line**
- **DARPA Always Interested in Good Ideas**
  - Engage DARPA Program Managers
  - Join DARPA as a Program Manager
- **DARPATech 2002 Symposium**

  July 30 – August 2

  Anaheim, CA